BUILDING PANEL FOR STRUCTURES ADAPTED TO CARRY LIVE AND DEAD LOADS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present application is directed to building structures.

2. Description of the Prior Art

In today's cost conscious environment, more buildings are being constructed using pre-fabricated wall panels. One type of pre-fabricated wall panel is formed of load-bearing metal studs. Several load-bearing metal stud wall panels may be used in conjunction with one another to support floor and roof structures so as to construct a complete building. The load-bearing metal stud wall panels are designed to carry the axial loads of a building. The lateral loads (wind load, seismic load, etc.) imposed on a building may be addressed and handled in several ways. A common method is to apply light gauge flat "x-strapping" to one or both sides of the metal stud panels in specifically designed quantities and locations. The x-straps usually consist of light gauge flat sheet metal strips welded or screwed to the wall panel frame positioned between or on the face of the vertical studs forming an x-shape. As a lateral load is applied to the building, one leg of the "x" is placed in tension and carries the lateral load while the other leg of the "x" goes into compression and can deflect and become wavy. Although great care may be taken to ensure the x-straps get installed flat and tight, as the building gets loaded during construction, uneven concrete slab bearing surfaces as well as incremental settlements can create compression deflection and waviness of the flat straps. This can create a structurally ineffective x-strap as well as a finishing problem. In addition, depending upon the wind loads and the design approach; many times there is a positive net uplift when the x-straps receive lateral load. This uplift is usually accounted for by some kind of floor-to-floor through bolt or strap connection at the ends of the x-straps. Some engineers design their own steel connection brackets and bolts, while others utilize various anchors offered by manufactures such as "Simpson". These connections can be tedious, time consuming, difficult, and expensive to install.

Other problems with the "x-strapping" are:

1. They may be cut or damaged by plumbers and electricians after installation; and

2. If the concrete slab surface supporting the x-strapped shear wall is uneven and not flat, incremental racking of the x-strapped panel as the building gets constructed and loaded causes one strap to pre-load into tension (actually diminishing its ability to carry the lateral load it was designed for). The other strap goes into compression causing deflection and waviness of the strap.

3. The deflection or wavy x-strapping will cause bulges and/or a finishing problem in the drywall that is applied over the x-strapped walls.

4. The x-straps cannot be tightened or loosened easily after installation and loading.

Therefore, an object of the present invention is to overcome these problems.

SUMMARY OF THE INVENTION

The present invention is directed to a load-bearing metal stud shear wall panel and corner bracket arrangement that utilizes round steel rods within the stud cavity (versus applying material to the face of stud) to carry the lateral loads. The brackets include a plurality of holes that permit interconnectability of shear panels between floors. The shear panels are attached to each other between floors through the bracket arrangement. The brackets also include a convex or curved element on the inside face which is adapted to provide even bearing for the nuts and washers and distribute the tensile loads of the diagonal rods as the rods enter the bracket at various angles over a multitude of floor-to-floor heights. The end result is a load-bearing metal stud structure that has multiple floors.

Another aspect of the present invention is the floor-to-floor connection of shear panels via the corner brackets. After a shear panel is installed and the metal floor decking is installed on top of it, the bracket permits easily installing the floor-to-floor through bolt prior to the concrete pour.

Two techniques may be employed. The through bolt may be inserted all the way up through the bracket in its fully extended position and the concrete poured around it, embedding the bolt in concrete with enough bolt protruding up past the top-of-slab to attach the lower bracket of the shear panel above. The other technique is to insert the through-bolt through the upper bracket, but position the end of the bolt at an elevation

just below the top of the concrete slab to be poured above. The bolt protruding into the area above should be greased or taped to prevent it from becoming hard-cast into the concrete. Within a short period after the concrete is poured and while the concrete is still relatively "green", the through-bolt is moved (such as by rotating) upward and passes through the upper surface of concrete to its fully extended position. The shear panel above is then placed over the protruding rods and connected with nuts and washers, creating a positive floor-to-floor uplift connection.

Another aspect of the present invention is the ability to easily loosen or tighten the tension on the cross rod bracing by adjusting the nut at the end of the rod. This may be done after installation and after several floor loads have been applied. The adjustment can be made with a simple wrench, and does not require any cutting or welding.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an elevational view of a panel made in accordance with the present invention;

Fig. 2 is a schematic representation of the panel shown in Fig. 1 schematically showing the working loads;

Fig. 3 is an elevational view of a portion of a structure having two panels and a flooring attached thereto;

Fig. 4 is an elevational view of a portion of a panel adapted to be installed in a concrete floor (at slab-on-grade or the base floor slab);

Fig. 5 is a plan view of a bracket made in accordance with the present invention;

Fig. 6 is an elevational view of another embodiment of a panel made in accordance with the present invention;

Fig. 7 is a front view of the bracket shown in Fig. 5;

Fig. 8 is a partial elevational view of two panels shown in Fig. 6 secured to a floor;

Fig. 9 is a sectional view of a bracket shown in Fig. 1;

Fig. 10 is a top perspective view of the bracket shown in Fig. 9;

Fig. 11 is an elevational view of a panel made in accordance with the present invention;

Figs. 12-15 show a bracket similar to the bracket shown in Figs. 9 and 10; and

Figs. 16 and 17 are partial plan views showing the brackets of the present invention welded to a panel.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 shows a panel 10 made in accordance with the present invention. Specifically, panel 10 is rectangular-shaped and includes a first track 12, a second track 14 and end studs 16 and 18. The tracks 12 and 14 and studs 16 and 18 define a rectangular profile that includes a first corner 20, second corner 22, third corner 24 and fourth corner 26. The tracks 12 and 14 and studs 16 and 18 can be of any gauge thickness. Brackets 28, 30, 32 and 34 are attached within the respective corners 20, 22, 24 and 26. A plurality of longitudinally-extending studs 35 are positioned between the tracks 12 and 14 and studs 16 and 18. The number of studs 35 is dependent on the width of the respective tracks 12 and 14. The arrangement shown in Fig. 1 includes a ten foot wide track wherein the studs 35 are spaced apart by 24 inches. Diagonal crossing members 36 and 38 are provided. The crossing members 36 and 38 essentially are round bars having threaded ends received within respective brackets 28, 30, 32 and 34. Specifically, ends of crossing member 36 are received by brackets 30 and 34. The diagonal crossing members are held in place through a nut and washer arrangement abutting against an inner surface of the respective brackets 30 and 34. Likewise, diagonal crossing member 38 is received by respective brackets 28 and 32. The brackets 28, 30, 32 and 34 are held in place by nut and washer arrangements that abut against an inner surface of the brackets 28 and 32. The brackets 28, 30, 32 and 34 are welded to respective tracks 12 and 14 and studs 16 and 18. Connecting members 40' and 42' are received by respective brackets 34 and 32 of the shear panel above. The connecting members 40 and 42 are threaded rods or bolts that pass through respective holes defined in the brackets 34 and 32. The connecting members are sufficient length to pass through adjacent flooring so that opposite ends of the connecting members 40' and 42' may be attached to respective brackets on adjacent and vertically-spaced panels 10. Connecting members 40 and 42 are threaded rods at the lowest shear panel that are epoxied into the base support slab (slab-on-grade, etc.).

Referring to Fig. 2, the brackets 28, 30, 32 and 34 are physically attached, via welding, to the corners 20, 22, 24 and 26 of the panel 10. Typically, the nut arrangements on the specific ends of the crossing members 36 and 38 are tightened and panel 10 can have a working lateral shear load of 5500 pounds. Generally, this can be accomplished through a three quarter inch rod made of grade A36 carbon steel.

Referring to Fig. 3, the attachment of the connecting members 40' and 42' can be seen. Specifically, connecting member 40' not only passes through respective brackets 28 and 34', but also passes through a floor member 54. This floor member 54 can be but is not be limited to, a composite floor member such as the EPICORE® composite floor and roof deck systems manufactured by Epic Metals Corporation of 11 Talbot Avenue, Rankin, Pennsylvania 15104. The present invention can also be used with other types of floorings. The floor member 54 includes a metal profiled member 55 on which a concrete slab 56 is poured. The panels 10 and 10' and floor members 54 form a structure 52, such as an apartment building.

If panels 10 are to be installed only onto a concrete slab (i.e., slab-on-grade or the base level slab), then an anchorage member 58 may be used in lieu of the connecting members 40 and 42, as shown in Fig. 4. The anchorage member 58 may include epoxy and be laid in the concrete.

Figs. 5 and 7 show a bracket 60 made in accordance with the present invention and a bracket 60 which is shown partially in sections and is similar to bracket 28. Bracket 60 includes a bracket body 62 having five sides 64, 66, 68, 70 and 72. Aligned connecting member holes 74 and 76 are provided on sides 68 and 64, respectively. A tapered hole 78 adapted to receive the diagonal crossing members is defined on side 70. Sides 64 and 66 are defined at right angles to each other so that they may be received by the respective corners of panel 10. As can be seen, side 70 has an angled surface relative to the bracket to permit the angled or diagonal crossing members 36 or 38 to be received therein. The slot opening or hole 78 is a sufficient size to accommodate varying angles of the diagonal crossing member 36 or 38. Fig. 6 shows another panel 10" that utilizes the bracket 60. All other elements are the same. The bracket 60 utilizes a piece of pipe through which the connecting members pass. Specifically, referring to Fig. 8, the ends of the connecting members pass through a pipe member 80 having slots defined on opposite sides thereof for receipt of the ends of the

crossing members 36 and 38. The pipe distributes the load accordingly as shown in Fig. 8. Alternatively, Fig. 8 shows a D-shaped member 82 may be used in lieu of the pipe so that the curved portion of the D-shaped member 82 rests against inner surfaces of the bracket. Alternatively, bracket 60 need not include five sides but can include four sides utilizing the pipe 80 or D-shaped member 82 to abut against respective sides of the bracket as shown in Fig. 8.

Figs. 9, 10 and 12-15 show the brackets 28, 30, 32 and 34 in more detail. Essentially the brackets, which are all the same and therefore only bracket 28 will be described, include a bracket body 44 having five sides 45a, 45b, 45c, 45d and 45e. Sides 45b and 45c are the sides which are welded to the respective tracks 12 and 14 and studs 16 and 18. Figs. 16 and 17 show brackets 28 and 34 welded to respective tracks 12 and 14 and stud 16 at points A, B, C and D. The bracket 28 includes two aligned slots 46 and 47 which are defined on surfaces 45a and 45c, respectively. Slot 48 is defined on side 45d. The slot 48 includes a curved load-bearing inner surface 50 defined on member 45d. The slot 48 in Fig. 14 is tapered while the corresponding slot in Figs. 12-19 is not tapered. Essentially, sides 45a and 45b are right angles to each other and adapted to be received in respective corners 20, 22, 24 and 26. Slots 46 and 47 are adapted to receive the connecting members 40, 42, 40' and 42', respectively, and the end slot 48 is adapted to receive diagonal members 36 and 38. The curved load-bearing member 50 is adapted to coact with a washer or nut to abut thereto to evenly distribute the loads caused by the tension of the diagonal crossing members 36 and 38 to be evenly distributed even at various rod angles. Preferably, the brackets 28, 30, 32 and 34 are made of A grade 148 grade 40-60 carbon steel.

Referring to Fig. 11, panels 10 made in accordance with the present invention show that initially the studs include respective punch out slots. The studs can be of any gauge thickness. This permits the diagonal crossing members 36 and 38 to pass through certain portions of the studs as identified through C2, C3, C4 and C5. Initially, the crossing members 36 and 38 pass through the respective studs, then the studs at brackets 28, 30, 32 and 34 are attached. The diagonal crossing members 36 and 38 may be tensioned to the appropriate tensile force at any time prior to covering the wall panels with drywall.

The base floor slab or slab-on-grade of a structure is typically concrete. Preferably, panels 10 are attached to the first floor concrete via anchors 58 as previously described. Then, the decking 55 is attached to the upper tracks 12 of the respective panels. Connecting members 40' and 42' are then attached to respective brackets 32 and 34 so as to extend a fixed distance above the decking 55. The concrete flooring 56 is then poured around and embedding, the connecting members 40' and 42' forming the flooring member 54. This will result in a relatively level flat floor 54. If members 40' and 42' are only partially extended to just below the top-of-slab surface, a lubricant, such as grease, is placed on the upper threaded ends of the connecting members 40 and 42, which are embedded in the concrete flooring 56. Soon after the pour or when the green concrete hardens sufficiently to walk on, the connecting members 40' and 42' are rotated and moved upward to their fully extended position so that the connecting members 40' and 42' extend well above an upper surface of the concrete flooring 56. Next, a plurality of panels 10 may now be installed on the upper surface of the concrete flooring 56. The respective connecting members 40' and 42' then can be received by respective brackets 28 and 30 and attached thereto such as shown in Fig. 3. This process then can be repeated for each floor added to the structure. One advantage to this method is that the concrete floor 56 can be poured flat. Prior art methods of passing connecting members through concrete flooring have always resulted in the concrete being poured around the connecting member and creating an uneven floor around the connecting member. The panels are stressed after installation in the building. In this manner, the building panel 10 is adapted to carry axial live and dead loads and lateral loads. This resulted in subsequent work to level the flooring. Alternatively, drills have been used to drill holes in the concrete floor for receipt of the connecting member. The present invention overcomes this problem. Further, the present invention overcomes the problem of the prior art "x-strapping".